# Photo-induced transformation in a cell-sized lipid vesicle

AUTHOR(S):

Hamada, Tsutomu

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# Photo-induced transformation in a cell-sized lipid vesicle

School of Material Science, Japan Advanced Inst. Sci. tech. Tsutomu Hamada [1]

生体内では脂質膜に埋め込まれた高分子の光異性化反応による構造変化が、情報伝達などの重要な機能を引き起こしている。このような生体膜のモデルとしてリン脂質 DOPC(dioleoyl-phosphatidylcholine) に光感受性脂質を混合した細胞サイズのベシクルを作製し、光応答の顕微鏡直接観察を行った。トランス体-シス体間の異性化反応により、球状のベシクルでは膜面の揺らぎが変化し、洋ナシ型のベシクルは小さなベシクルの出芽挙動を示した。これら形態変化のメカニズムは、異性化反応にともなう構成分子の分子断面積の増減を考慮した自由エネルギーにより説明される。

In biological systems, change in the conformation of photosensitive molecules embedded in membranes, such as rhodopsin etc., play important physiological roles. Many studies have been conducted to prepare artificial photosensitive vesicles, and have reported changes in the permeability of ions and/or water-soluble compounds across the membrane upon photo-isomerization. In these studies, small vesicles (~100 nm) have frequently been used, which implies that the direct observation of morphological change in individual vesicles is impossible. In contrast, cell-sized vesicles ($\geq$10 $\mu$m) can be used as a suitable model system for observing transformational processes in real-time.

In this study, we designed and synthesized a photosensitive amphiphilic molecule containing azobenzene (KAON12); the conformation (trans or cis) of this molecule can be switched by light (Figure 1-A). Cell-sized vesicles were prepared from dioleoyl-phosphatidylcholine, DOPC, and KAON12 through natural swelling ([KAON12]/[DOPC] = 60 M/100 M). Photo-isomerization induces a change in membrane fluctuation behavior or a morphological transition between ellipsoid and bud shapes, depending on the asymmetrical degree of the initial shape. Figure 1-B shows the results of the photo-irradiation on an asymmetrical vesicle. After UV irradiation, the asymmetric vesicle exhibits budding. Interestingly, the budded vesicle transforms back to the original ellipsoidal shape upon treatment with green light. This reversible change in morphology is observed more than ten times (Fig. 1-C). While the pathways of the transformation are different somewhat between the forward and reverse processes, the switching between the two stable states is reversible. We evaluate a change in membrane area during photo-isomerization by measuring $\Pi$-A curve, and discuss the mechanism of this reversible photo-switching in the

[1]E-mail: t-hamada@jaist.ac.jp

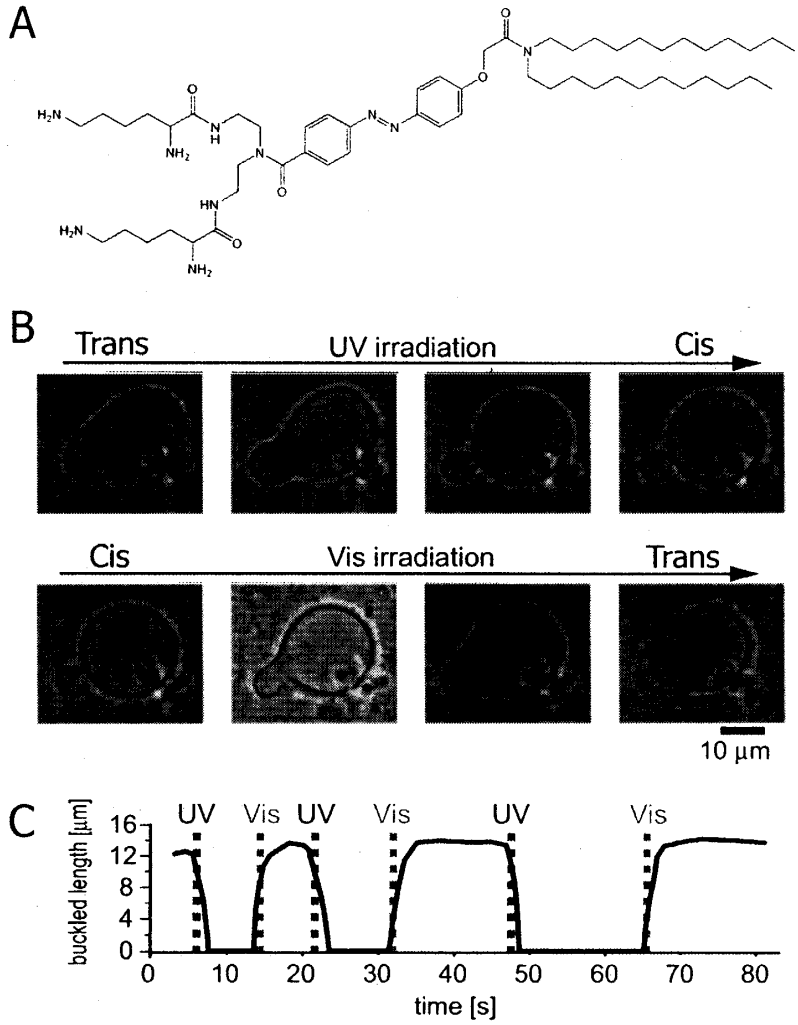


Figure 1: A) Chemical Formula of KAON12. B) Photo-induced reversible ellipsoid-bud transition in a cell-sized vesicle. The transformation from ellipsoid to bud induced by UV light is shown (Upper). The reverse process from bud to ellipsoid induced by irradiation with green light is shown (Lower). C) Repetitive photoswiching of the morphology. The time development of the neck length on the buckled part in the ellipsoid-bud transformation is shown.

vesicle morphology in relation to the effective cross-sectional area of the photosensitive molecule.

## References

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